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Final Assembly of Cryogenic Targets for NIF

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Disclaimer

Final Assembly of Cryogenic Targets for NIF

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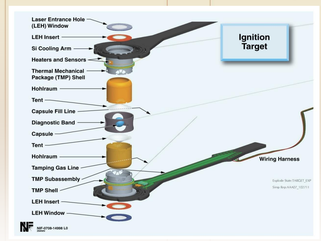
Final Assembly Machine (FAM)

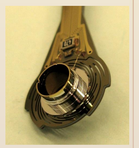


Ignition Target

The FAM consists of an LLNL-developed manipulator system integrated with a commercial Optical Coordinate Measurement Machine (OCMM) in a class 100 clean room. Target components are assembled with micron level accuracy at a rate of one target per day,

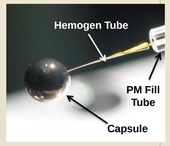
Sub-Assemblies

Thermal Mechanical Package (TMP) Sub-Assembly



The TMP Sub-Assembly contains a Hohlraum, precisely inserted into an aluminum shell, that is bonded to a Silicon arm. A 110nm thick Formvar tent is applied to the Hohlraum to provide capsule support during assembly and heaters and sensors are bonded to the arm and the shell to provide thermal control of the Hohlraum fill gas.

Capsule Fill-Tube Assembly (CFTA)

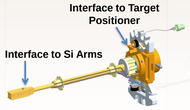


The Capsule Fill-Tube Assembly consists of a spherical CH ablator attached to a 10um OD Hemogen tube. The Hemogen tube transitions to a 150 micron OD Polymicro (PM) tube. The CFTA is centered in the Diagnostic Band and captured by the tented TMP Sub-Assembly during assembly.

Diagnostic Band

The Diagnostic Band joins the two TMP Sub-Assemblies and establishes overall target length. Multiple ports on the Diagnostic band enable vacuum tooling access to the Capsule and viewing during assembly.

Base Sub-Assembly



The Base Assembly provides the mechanical and electrical interface between the target and the target positioner including utility connections for the gas lines, heaters, and sensors.

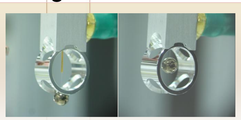
Integration of complex components and sub-assemblies to exacting assembly tolerances requires a robust, deterministic approach to final assembly

Final Assembly Process Flow

CFTA Threading

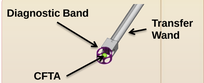
The Diagnostic Band is loaded into the Handoff Wand at the Threading Station

The CFTA is threaded through the Diagnostic Band and into the Transfer Wand



The Capsule is pulled into the Diagnostic Band through the access port

Threaded CFTA Handoff and Alignment



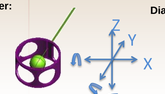
The threaded CFTA is positioned on the FAM for handoff

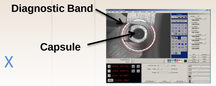
Diagnostic Band and Capsule Vacuum Wands capture their respective components

The Transfer Wand is retracted to support only the Fill-Tube

Capsule positioning at build center:
X, Y, Z <0.003 mm
ΘX, ΘZ, <200 mrads

Diagnostic Band positioning at build center:
X, Y, Z <0.003mm
ΘX, ΘY, <0.5 mrads
ΘZ <2 mrads



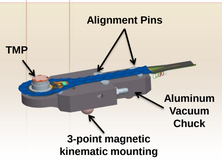


Centering measurements are made using OCMM software

Loading the TMPs

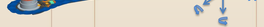
Loading a TMP onto the FAM

The silicon arm of the TMP sits flat on the vacuum chuck and is positioned against pins for pre-alignment. Errors in pre-alignment can cause unwanted forces and torques during final assembly



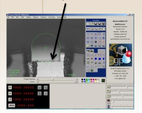
TMP Alignment

TMP positioned at build center:
X, Y, Z <0.003mm
ΘX, ΘY, <0.5 mrads
ΘZ <2 mrads



TMP ID

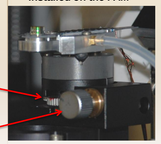
TMP ΘZ Alignment Notch



ΘX and ΘY adjustments

ΘZ adjustment

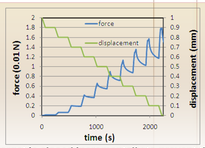
TMP in vacuum chuck installed on the FAM



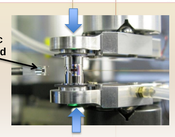
Centering and rotation measurements are made using the OCMM Software

ΘX- Θ Y tip-tilt and ΘZ rotation adjustments are made by hand, while X, Y and Z positional adjustments are made using motorized staged

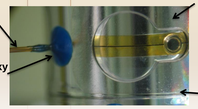
Final Assembly



The target is closed incrementally to prevent the tents from tearing as they stretch around the capsule.

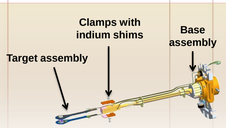


The target is closed using two separate motorized Z axis stages that are slaved together to operate simultaneously



After the target is closed epoxy is used to bond the target together

Completed Final Assembly

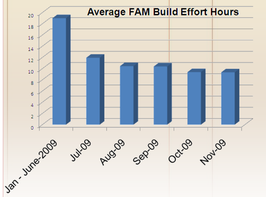


After the target epoxy is cured, the base is inserted between the TMP silicon arms and attached to the target

The target leaves the FAM ready for window and gas line installation and final bonding

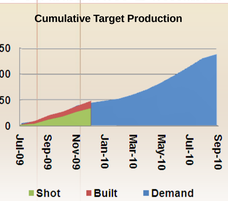
Precision tooling coupled with in-process metrology and operator feedback enables successful assembly of NIF cryogenic targets at rates commensurate with target demand

Build Times



Process improvements combined with learning curves dramatically reduced build times

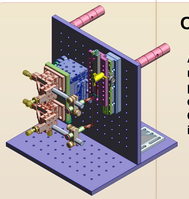
Production Demand



The NIF continues to demand high quality cryogenic targets at record production rates

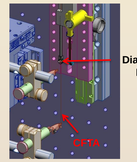
Future Advancements

CFTA Threading Station



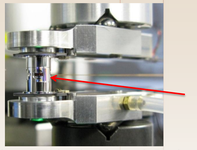
New CFTA Threading Station

A new CFTA Threading Station with multi-axis component control will provide a more robust assembly environment that reduces risk to the CFTA while increasing throughput in a cleaner operation



CFTA threading into the Diagnostic Band

Modified FAM Bonding Process

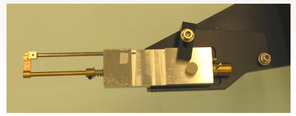


Eliminate CFTA bond to Diagnostic Band

Eliminating slow curing epoxies from the final assembly process will decrease time-on-machine and increase target throughput on the FAM. A development effort in under way to qualify a new process that eliminates the capsule fill-tube bonding step at the FAM and moves it to the Bonding Station where all final bonding procedures are performed

New Transfer Wand and Mounting Hardware

A new Transfer Wand was designed to enable easier, repeatable mounting and alignment, allow compatibility with other assembly stations and provide a cleaner process



Going forward the final assembly process will continue to evolve to meet the exacting specifications and demands of the National Ignition Campaign

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Lawrence Livermore National Laboratory

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